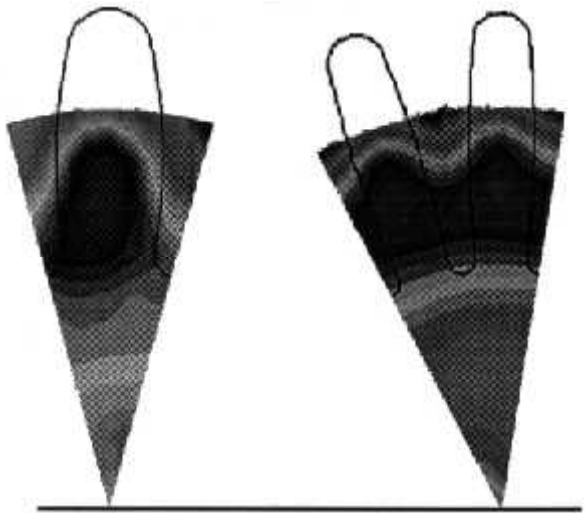
Subsonic Jet Noise Reduced With Improved Internal Exhaust Gas Mixers

Aircraft noise pollution is becoming a major environmental concern for the world community. The Federal Aviation Administration (FAA) is responding to this concern by imposing more stringent noise restrictions for aircraft certification then ever before to keep the U.S. industry competitive with the rest of the world. At the NASA Lewis Research Center, attempts are underway to develop noise-reduction technology for newer engines and for retrofitting existing engines so that they are as quiet as (or quieter than) required. Lewis conducted acoustic and Laser Doppler Velocimetry (LDV) tests using Pratt & Whitney's Internal Exhaust Gas Mixers (IEGM). The IEGM's mix the core flow with the fan flow prior to their common exhaust.

All tests were conducted in Lewis' Aero-Acoustic Propulsion Laboratory--a semihemispheric dome open to the ambient atmosphere. This was the first time Laser Doppler Velocimetry was used in such a facility at Lewis. Jet exhaust velocity and turbulence and the internal velocity fields were detailed. Far-field acoustics were also measured. Pratt & Whitney provided 1/7th scale model test hardware (a 12-lobe mixer, a 20-lobe mixer, and a splitter) for 1.7 bypass ratio engines, and NASA provided the research engineers, test facility, and test time. The Pratt & Whitney JT8D-200 engine power conditions were used for all tests.

The Laser Doppler Velocimetry measurements at the common exhaust nozzle showed the presence of high-velocity regions at the nozzle exit which directly corresponded to the mixer lobes (see figure). The 12-lobe mixer had 12 high-velocity regions, and the 20-lobe mixer had 20. The radial mean velocity between the mixers was nearly equivalent, but it was approximately 300 ft/sec slower than the radial mean velocity with the splitter. The turbulence intensity, with respect to the centerline velocity, reached about 12 percent between the core and the fan shear layer for the splitter. The 20-lobe mixer had about the same intensity, but the 12-lobe mixer had about 16-percent turbulence intensity.



Laser Doppler Velocimetry data from the subsonic jet noise program.

The acoustic data showed that both mixers were quieter than the splitter nozzle. This is a direct consequence of reductions in the mean jet exhaust velocities. The mixing between the core and the fan within the IEGM created the high-frequency noise. The mixing noise for the 12-lobe mixer was higher than that for the splitter, and the 20-lobe mixer had the quietest mixing noise. When scaled to constant full-scale thrust, the 20-lobe mixer was approximately 7.5-effective perceived noise decibels (EPNdB) quieter than the splitter and approximately 2 EPNdB quieter than the 12-lobe mixer. Efforts are continuing to make these IEGM's reach the Federal Aviation Administration's noise limits. Lewis, in cooperation with industry, is continuing to advance the research and technology to quiet U.S. aircraft engines.